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| 4. TITLE AND SUBTITLE A Proposal for the Organization of the Sixth Workshop on Wide Bandgap Nitrides | | 5. FUNDING NUMBERS Grant #DAAD19-00-1-0458 | | |
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| <p>This workshop brought together researchers worldwide to discuss semiconductor nitrides. This workshop provided an open forum which facilitated exchange of knowledge and information about recent developments in equipment, growth methods, growth issues particular to each method including lateral growth and associated spatial migration rates, new theoretical findings, dopant (both n and p type) incorporation and likely approaches to be employed, and potential applications to emitters, detectors and electronic devices.</p> <p style="text-align: center;">DTIC QUALITY INSPECTED 4 20010117 058</p> | | | | |
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Final Report, to be submitted to ARO and ONR, on

A PROPOSAL FOR THE ORGANIZATION OF THE SIXTH WORKSHOP ON WIDE BANDGAP NITRIDES

HELD MARCH 12-15, 2000 IN RICHMOND VA USA

SUBMITTED BY HADIS MORKOÇ
VCU

The workshop was a very successful one and attended by some 140 active researchers in the field. Over 120 abstracts were received and some 80 oral presentations heard in addition to some 20 poster papers. Technical Summary, Attendees List, Oral Presentation Program and Poster Presentation Program are attached as part of this final report.

Technical Summary of the Workshop

The workshop was organized by a group led by Cole Litton (Program Chair), with Hadis Morkoç (Local Arrangements Chair) responsible for the local arrangements. The venue was the Omni Richmond Hotel. The local arrangements were excellent.

In the following some selected topics treated in the workshop will be highlighted, we do not intend to provide a full coverage of all presentations and discussions.

Bulk growth and HVPE.

An update report was given on bulk growth from solution under slight overpressure. A GaN boule size of 20-mm length was reported. Growth on single crystalline GaN seeds is now pursued, and the produced material is on the way to being single crystalline. No further details were provided, neither on growth conditions (solvent used) nor on properties of the produced material.

Growth of bulk AlN with sublimation transport was discussed. Up to 13 mm diameter boules were produced, so far polycrystalline. The dislocation density was claimed to be below $5 \cdot 10^4 \text{ cm}^{-2}$.

Preliminary results were presented from low temperature ammono-thermal growth of GaN and AlN. Small mm size crystals were obtained. But so far no seeded growth has been accomplished.

Several reports were given on the growth of thick epilayers with the HVPE technique. By growing very thick GaN layers on sapphire a dislocation density of about $3 \cdot 10^6 \text{ cm}^{-2}$ at the top surface was reported. Production of thick freestanding layers by growth on LGO substrates and subsequent etching was reported, a size of 2" was predicted soon. There was a rumor that a company in Japan will soon offer thick 2" freestanding GaN wafers, from growth on GaAs.

MOVPE growth

The LEO technique was discussed, and the growth of LEO-PENDEO GaN has now been successfully demonstrated on silicon substrates. Another study reported on in situ XRD experiments monitoring the development of tilt during LEO growth of GaN on sapphire with a SiO_2 masking. Clearly the tilt does develop during growth, only a very small part of it has to do with cool-down stress. The temporal development of tilt during growth was displayed. The growth conditions may be optimized to minimize this tilt, in order to avoid a large dislocation density in the coalescence region of the overgrown layers.

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Properties of GaN.

MOVPE grown GaN buffer layers on sapphire were shown to have a resistivity that depended on the dislocation density. Varying the growth conditions (such as reactor pressure) the dislocation density could be systematically controlled, with a strong correlation with the resistivity of the layer. Acceptor states related to the threading dislocations were held responsible for this effect, which is important for FET devices grown on GaN.

Schottky barrier measurements of the vertical transport properties in MBE grown GaN layers were presented. It was concluded that the vertical mobility in such layers is less affected by the dislocations, i.e. while the lateral mobility was $200 \text{ cm}^2/\text{Vs}$ the vertical mobility was in the range $1000 \text{ cm}^2/\text{Vs}$ at room temperature.

A careful study of Mg doped GaN layers was presented, comparing SIMS, Hall data, EPR and ODMR. The Hall concentration tracks well with the uncompensated Mg concentration found in EPR ($4 \times 10^{19} \text{ cm}^{-3}$). A concentration of compensating donors in the 10^{18} cm^{-3} range was found, of unknown origin (not Si or O). Interestingly the blue PL emission in this material was suggested to be connected with a shallow donor from ODMR data, i.e. not a deep donor as commonly believed.

Profiling studies of point defects in thick (about $50 \mu\text{m}$) HVPE grown GaN layers were reported. While the concentration of Ga vacancies strongly increased towards the substrate (positron annihilation data) the yellow luminescence (YL) intensity appeared to have a strong opposite trend. This is in disagreement with the previous wisdom from MOVPE layers.

QW structures

Theoretical estimates of the exciton binding energy in AlGaIn/GaN QWs were presented. It was concluded that the polarization fields as well as the screening effects by photo-induced carriers in optical experiments have a dramatic effect on the exciton binding energy, which may be reduced to about 10 meV. Under these conditions it is questionable whether the room temperature PL emission is of excitonic character, it should rather be free carrier recombination. Similar arguments would apply to InGaIn/GaN QWs.

The electron mobility for the 2DEG in AlGaIn/GaN structures grown on low dislocation density ($<10^4 \text{ cm}^{-2}$) GaN substrates showed a record value of about $60,000 \text{ cm}^2/\text{Vs}$ at low temperatures.

Inter-subband electron transitions were studied in AlGaIn/GaN MQWs. Absorption data for structures grown with $0.45 < x < 0.8$ showed absorption bands in the range $1.8 - 4 \mu\text{m}$. Such structures might be of interest for THz optical modulators.

Devices

Status reports were given for several devices, including lasers, MODFETs, HBTs and photodetectors. We shall not give details here. It appears like high performance MODFETs may be produced at moderately high dislocation densities, but the device characteristics are influenced by defects, and possible long-term degradation problems have not yet been much studied. PNP HBTs were reported, these are easier to make (compared to NPN) since the p-doping bottleneck is avoided. A future design with a transferred substrate bottom collector was suggested. HBTs will be more sensitive to the dislocation density than MODFETs. Solar blind UV detectors showed very promising data, the performance was already rather close to the stringent specifications for military use.

Oral Presentation Program:

| Session | Time | Abstract # | Authors (Presenter's Name in Bold) | Contact e-mail | Title of Talk |
|---------|------|------------|------------------------------------|----------------|---------------|
|---------|------|------------|------------------------------------|----------------|---------------|

| | | | | | |
|--------|-------|----|---|---------------------------------|---|
| MA-1 | 8:15 | | Bulk and Composite Substrates - Richard Molnar, Robert Davis | | |
| MA-1.1 | 8:20 | 24 | R. P. Vaudo | bvaudo@atmi.com | Hydride Vapor Phase Epitaxy for Nitride Substrates Preparation and Characterization of Single-crystal Aluminum Nitride Substrates |
| MA-1.2 | 8:30 | 79 | Leo J. Schowalter, J. Carlos Rojo, N. Yakolev, Y. Shusterman, and G. Slack | schowl@rpi.edu | |
| MA-1.3 | 8:40 | 31 | M. Callahan, M. Suscavage, D. Bliss, P. Yip, S. Wang, D. Schwall, L. Bouthillette, J. Bailey, M. Harris, D. Look, D. Reynolds, R. Jones, C. Litton, H. Morkoc, and M. Reschchikov | Michael.Callahan@hanscom.af.mil | |
| MA-1.4 | 8:50 | 36 | V. Dmitriev, Yu. Melnik, V. Ivantsov, A. Nikolaev, V. Sukhoveev, I. Nikitina | vladimir@tdii.com | Development of AlN and GaN substrate materials |
| MA-1.5 | 9:00 | 48 | Y. Shi, Z. Y. Xie, L. H. Liu, B. Liu and J. H. Edgar | yshi@ksu.edu | |
| MA-1.6 | 9:10 | 28 | H. P. Maruska, J. Gallagher, B. Chai, T. Anderson, O. Kryliouk | maruska@gdi.net | Influence of Buffer Layer and 6H-SiC Substrate Polarity on the Nucleation of AlN Grown by the Sublimation Sandwich Technique |
| MA-1.7 | 9:20 | 69 | Joseph W. Kolis | Kjoseph@clemson.edu | |
| MA-1.8 | 9:30 | 39 | D. R. Gilbert, R. K. Singh, R. Abbaschian, R. Chodelka, F. Kelly, S. Pearton, A. Novikov, N. Patrin, and J. Budai | dgilb@mail.mse.ufl.edu | Approaches to Bulk Single Crystals of GaN in Supercritical Ammonia |
| MA-1HT | 10:00 | | 10:00-10:20 AM: Open Discussion & Hot Topics; 10:20-10:40 AM: Coffee Break | | |

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|--------|-------|---|--|---------------------------|---|
| MA-2 | 10:40 | | Structural Characterization and ELO Templates - Fernando Ponce, Zuzanna L-Weber, Robert Davis | | |
| MA-2.1 | 10:40 | 1 | Zuzanna Liliental-Weber | z_liliental-weber@lbl.gov | Effect of impurities and dopants on defect formation in GaN |

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|---------|-------|------------|--|---------------------------|--|
| MA-2.2 | 10:50 | 58 | K. Lorenz, V. Narayanan, W. Kim and S. Mahajan | Katharina.Lorenz@asu.edu | Defects in GaN nucleation layers grown on (0001) sapphire |
| MA-2.3 | 11:00 | 42 | L. Robins, J. Armstrong, C. Bouldin, A. Paul, J. Woicik, C. Parker, J. Roberts, S. Bedair, E. Piner, M. Reed, N. El-Masry, K. Miyano, S. Donovan, and S. Pearton | lawrence.robins@nist.gov | Optical and structural characterization of compositional inhomogeneity in strain-relaxed indium gallium nitride films |
| MA-2.4 | 11:10 | 34 | M. Twigg, R. Henry, D. Koleske, and A. Wickenden | twigg@estd.nrl.navy.mil | Dependence of extended defects in GaN on hydrogen and alkyl flow rates |
| MA-2.5 | 11:20 | 6 | R. Davis, T. Gehrke, K. J. Linthicum, T. S. Zheleva, E. A. Preble, P. Rajagopal, C. A. Zorman, M. Mehregany | Robert_Davis@ncsu.edu | Lateral and pendeo-epitaxial growth and characterization of gallium nitride and related materials on 6H-SiC(0001) and Si(111) substrates |
| MA-2.6 | 11:30 | 49 | Q. Fareed, V. Adivarahan, J. Zhang, M. Asif Khan, J. W. Yang, G. Simin, R. Gaska, and M. S. Shur | fareed@engr.sc.edu | Epitaxial Lateral Overgrowth of GaN on SiC Substrates With Vertically Conducting Buffers |
| MA-2.7 | 11:40 | 87 | P. Fini, G.B. Stephenson, C. Thompson, A. Munkholm, J. Eastman, R. Murty, S.P. DenBaars, and J.S. Speck | fini@engineering.ucsb.edu | In Situ, Real-Time X-ray Diffraction Measurements of Wing Tilt in Laterally Overgrown GaN |
| MA-2.8 | 11:50 | 89 | X. Zhang, P. D. Dapkus, and D. H. Rich | dapkus@usc.edu | Sparse GaN Nucleation Technique and Its Application to Direct Lateral Epitaxy Overgrowth of GaN on Sapphire |
| MA-2HT | 12:10 | | 12:10-12:40 PM: Open Discussion & Hot Topics; 12:40-2:00 PM: Break for Lunch, Omni Hotel | | |
| Session | Time | Abstract # | Authors (Presenter's Name in Bold) | Contact e-mail | Title of Talk |

III-Nitride Optoelectronic Devices - Steve DenBaars, Joe Campbell

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|--------|------|----|--|-----------------------------|--|
| MP-1.1 | 2:00 | 85 | M. Hansen, P. Fini, L. Zhao, J. S. Speck, and S. P. DenBaars | monica@engineering.ucsb.edu | Improved Characteristics of InGaN Multi-Quantum Well Laser Diodes Grown on Laterally Epitaxially Overgrown GaN on Sapphire |
| MP-1.2 | 2:10 | 97 | John Edmond | John_Edmond@Cree.com | Status of nitride based emitters on SiC |

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|--------|------|----|---|---------------------------------------|--|
| MP-1.3 | 2:20 | 78 | M. Osinski, G. A. Smolyakov, V. A. Smagley, C.-S. Fu, and P. G. Eliseev | osinski@chtm.unm.edu | Design of InGaN/GaN/AlGaIn VCSELs using electrical-thermal-optical- simulator |
| MP-1.4 | 2:30 | 23 | S. Bidnyk, J. B. Lam, B. D. Little, and J. J. Song | bidnyk@mail.com | Recent progress in the development of (Al, Ga)N lasing structures for near-and deep-ultraviolet emitters |
| MP-1.5 | 2:40 | 64 | V. Adivarahan, M. Shatalov, A. Lunev, J. W. Yang, G. Simin and M. Asif Khan | adivarah@engr.sc.edu | Vertically conducting quaternary AlInGaIn/GaN quantum well Light Emitting Devices over SiC substrates |
| MP-1.6 | 2:50 | 29 | A. J. Steckl, J. Heikenfeld, M. Garter, R. Birkhahn, D. S. Lee, and L. C. Chao | a.steckl@uc.edu | Rare Earth Doped GaN Electroluminescent Devices |
| MP-1.7 | 3:00 | 13 | V. Fuflyigin, A. Osinsky, F. Wang, P. Vakhutinsky, and P. Norris | vladf@nzat.com | Integrating ferroelectric oxides with III-nitride semiconductors: processing issues and device opportunities |
| MP-1.8 | 3:10 | 74 | J. I. Pankove, J. T. Torvik, A. Goulagov, and C. Menoni | pankove@indra.com | Hot-Electron-Driven Semiconductor Lasers |
| MP-1HT | 3:30 | | 3:30-4:00 PM: Open Discussion & Hot Topics; 4:00-4:20 PM: Coffee Break | | |
| MP-2 | 4:20 | | <i>III-Nitride Epitaxial Growth (MOCVD and CVD) - Russell Dupuis, Kathy Doverspike</i> | | |
| MP-2.1 | 4:30 | 98 | Kathy Doverspike | Kathy_Doverspike@Cree.com | Growth of Nitrides on SiC |
| MP-2.2 | 4:40 | 33 | H. Protzmann, M. Luenenbuerger, M. Bremser, M. Heuken and H. Juergensen | mb@aixtron.com | MOVPE of group-III-nitrides grown on 5x3 inch sapphire substrates in planetary reactors |
| MP-2.3 | 4:50 | 47 | D. Koleske, A. Wickenden, and R. Henry | koleske@estd.nrl.navy.mil | GaN decomposition in ammonia and its relationship to the GaN growth rate |
| MP-2.4 | 5:00 | 60 | Wook Kim, Mario Gonsalves, Vijay Narayanan and S. Mahajan | wook.kim@asu.edu | Defects in AlN nucleation and GaN epitaxial layer grown on c-plane sapphire substrate by MOCVD |
| MP-2.5 | 5:10 | 52 | G. Simin, J. Yang, M. Asif Khan, X. Hu, W. Knap, E. Frayssinet, R. Gaska, M. Shur, P. Prystawko, M. Leszczynski, I. Grzegory, and S. Porowski | simin@engr.sc.edu | High-density 2D electron gas in AlGaIn/GaN heterostructures over bulk GaN Substrates |
| MP-2.6 | 5:20 | 94 | M. Seyboth, C. Kirchner, and M. Kamp | matthias.seyboth@e-technik.uni-ulm.de | MOVPE Growth of AlGaIn: Experiment and Modelling |

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|---------|------|------------|---|------------------------------------|--|
| MP-2.7 | 5:30 | 95 | H. Y. A. Chung, C. Wang, M. Kamp | hin-yin.chung@e-technik.uni-ulm.de | Hydride Vapour Phase Epitaxy Growth of GaN Layers under reduced Reactor Pressure |
| MP-2.8 | 5:40 | 53 | M. Callahan, M. Harris, M. Suscavage, D. Bliss, J. Bailey, and M. Alexander | Michael.Alexander@hanscom.af.mil | Chemical vapor reaction process for III-N growth |
| MP-2HT | 6:00 | | 6:00-6:20 PM: Open Discussion & Hot Topics | | |
| Dinner | 7:00 | | 7:00-8:30 PM: Workshop Buffet Dinner, Omni Hotel | | |
| Rump | 8:30 | | 8:30-10:00 PM: Rump Session, Omni Hotel | | |
| Session | Time | Abstract # | Authors (Presenter's Name in Bold) | Contact e-mail | Title of Talk |

TA-1 8:00 III-Nitride Epitaxial Growth (MBE) - Tom Myers, Randall Feenstra, Cole Litton

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|--------|------|----|---|-------------------------|--|
| TA-1.1 | 8:00 | 91 | B. Heying, C. Elsass, Y. Schmorckova, E. Haus, L. Chen, P. Fini, S. DenBaars, U. Mishra, and J. Speck | benh@mrl.ucsb.edu | Nitrides by rf-assisted MBE on MOCVD-grown GaN |
| TA-1.2 | 8:10 | 5 | H. Tang, J. B. Webb, and J. A. Bardwell | Haipeng.Tang@nrc.ca | Reproducibility of growing high quality GaN MODFET structures by reactive (ammonia) MBE |
| TA-1.3 | 8:20 | 30 | C. Lee, H. Chen, V. Ramachandran, R. M. Feenstra, W. Sarney and L. Salamanca-Riba, D. Look, W. J. Choyke, R. Devaty, J. Northrup, T. Zywietz, J. Neugebauer, and D. Greve | feenstra@andrew.cmu.edu | Heteroepitaxy of GaN on SiC, and studies of Surface Structure |
| TA-1.4 | 8:30 | 43 | Tom Myers | tmyers@wvu.edu | Mg Incorporation Kinetics During rf Plasma MBE Growth |
| TA-1.5 | 8:40 | 2 | S. Guha, N. Bojarczuk, M. A. L. Johnson, J. Schetzina | guha@us.ibm.com | Luminescent gallium nitride based nanostructures on silicon substrates: faceted pillars and flowerlike strings |
| TA-1.6 | 8:50 | 73 | M. A. Reschikov, J. Cui, F. Yun, A. Baski, M. I. Nathan, R. Molnar and H. Morkoç | hmorkoc@vcu.edu | GaN Quantum Dots |
| TA-1.7 | 9:00 | 9 | H. M. Ng, C. Gmachl, S. N. G. Chu, F. Capasso and A.Y. Cho | hnmng@lucent.com | Growth of AlGaIn/GaN superlattices for intersubband transitions |

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|--------|------|----|---|-------------------|--|
| TA-1.8 | 9:10 | 84 | H. Lamb, A. McGinnis, D. Thomson and R. Davis | lamb@eos.ncsu.edu | Epitaxial Growth of GaN Using Seeded Supersonic Molecular Beams |
| TA-1HT | 9:30 | | 9:30-10:00 AM: Open Discussion & Hot Topics; 10:00-10:20 AM: Coffee Break | | |

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|---------|-------|---------------|--|-------------------------------|---|
| TA-2 | 10:20 | | Optical Characterization of III-Nitrides, Alloys and Modeling - Bo Monemar, John Zavada | | |
| TA-2.1 | 10:20 | 96 | B. J. Skromme and G. L. Martinez | skromme@asu.edu | Optical signatures of donors and acceptors in-GaN |
| TA-2.2 | 10:30 | 56 | U. Ozgur, M. Bergmann, H. Casey, Jr., H. Everitt, A. Abare, S. Keller, and S. Denbaars | everitt@aro-emh1.army.mil | Sub-picosecond optical measurements of carrier relaxation in InGaN multiple quantum wells |
| TA-2.3 | 10:40 | 55 | M. Wraback, H. Shen, J. C. Carrano, T. Li and J. C. Campbell | mwraback@arl.mil | Optical Time-of-Flight Measurement of the Electron Velocity-Field Characteristic in GaN |
| TA-2.4 | 10:50 | 76 | H. K. Kwon, C. J. Eiting, D. J. H. Lambert, M. M. Wong, and R. D. Dupuis | dupuis@mail.utexas.edu | Time-Resolved Photoluminescence Studies of AlGa1- xN/GaN Heterostructures Grown by MOCVD |
| TA-2.5 | 11:00 | 18 | G. Pozina, J. P. Bergman, B. Monemar, T. Takeuchi, H. Amano, and I. Akasaki | bom@ifm.liu.se | Multiple peak luminescence due to surface damage in InGaN/GaN multiple quantum well structures |
| TA-2.6 | 11:10 | 20 | H. J. Lozykowski, W. M. Jadwistenczak and I. Brown | lozykows@bobcat.ent.ohiou.edu | Luminescence of GaN Doped with Rare Earth |
| TA-2.7 | 11:20 | 16 | M. Reed, N. El-Masry, C. Parker, J. Roberts, and S. Bedair | mjreed@eos.ncsu.edu | Critical Layer Thickness Determination of GaN/InGaN/GaN Double Heterostructures |
| TA-2.8 | 11:30 | 92 | R. Cingolani, G. Traetta, A. Passaseo, A. DiCarlo, P. Lugli, M. Berti, A. Drigo and H. Morkoç | roberto.cingolani@unile.it | GaN quantum wells as mesoscopic capacitors: impact on electronic and excitonic states |
| TA-2HT | 11:50 | | 11:50-12:20 PM: Open Discussion & Hot Topics; 12:20-2:00 PM: Break for Lunch, Omni Hotel | | |
| Session | Time | Abstract # | Authors (Presenter's Name in Bold) | Contact e-mail | Title of Talk |

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|------|------|--|--|--|--|
| TP-1 | 2:00 | | Electrical Characterization of III- Nitrides, Alloys & Modeling - Ted | | |
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| Moustakas, Jacques Pankove | | | | |
|---|------|----------|---|---|
| TP-1.1 | 2:00 | 99 | John Northrup northrup@parc.xerox.com | Theoretical studies of Indium on the surfaces of GaN |
| TP-1.2 | 2:10 | 4 | R. Schlessner, R. Collazo, and Z. Sitar raoul_schlessner@ncsu.edu | Hot electron transport measurements in ALN |
| TP-1.3 | 2:20 | 15 | D. Florescu, V. Asnin, F. Pollak, A. d'florescu@its.brooklyn.cuny. Jones, J. Ramer, M. Schurman, and I. Ferguson | Thermal Conductivity of Fully and Partially Coalesced Lateral Epitaxial Overgrown GaN/Sapphire (0001) Using a Scanning Thermal Microscope |
| TP-1.4 | 2:30 | 40 | A. Hierro, D. Kwon, S. Ringel, M. ringel@ee.eng.ohio-hansen, J. Speck, U. Mishra, and S. state.edu | Detection, properties and hydrogenation of deep levels in n-GaN |
| TP-1.5 | 2:40 | 81 | M. Misra, A. Sampath, and T.D. tdm@bu.edu (T.D. Moustakas) | Vertical transport in n-GaN films |
| TP-1.6 | 2:50 | 90 | A. Saxler, P. Debray, R. Perrin, S. adam.saxler@afrl.af.mil Elhamri, W. C. Mitchell, C. R. Elsass, I. P. Smorchkova, B. Heying, E. Haus, P. Fini, J. P. Ibbetson, S. Keller, P. M. Petroff, S. P. DenBaars, U. K. Mishra and J. S. Speck | Characterization of an AlGaIn/GaN two-dimensional electron gas structure |
| TP-1.7 | 3:00 | 88 | R. Singh, C.R. Eddy, Jr. and A. cedly@bu.edu Aleksanyan | Contacts to Plasma Processed GaN Surfaces |
| TP-1.8 | 3:10 | 68 | E. Bellotti, M. Goano, E. Ghillino, C. bellotti@zeppo.mirc.gatech. Garetto, M. Farahmand, K. F. Brennan and G. Ghione | Material Based Device Modeling of the Ternary III-Nitride Alloys |
| TP-1HT | 3:30 | | 3:30-4:00 PM: Open Discussion & Hot Topics; 4:00-4:20 PM: Coffee Break | |
| UV Sensors and Solar Blind UV Detectors - Hadis Morkoc, Jan Schetzina | | | | |
| TP-2 | 4:20 | | Overview of UV Detectors | |
| TP-2.0 | 4:20 | overview | J. Schetzina jan_schetzina@ncsu.edu | Overview of UV Detectors |
| TP-2.1 | 4:25 | 7 | P. Schreiber, G. Smith, T. Dang, D. paul.schreiber@wpafb.af.mil Agrestra, and J. Scheihing | A Perspective of GaN/AlGaIn Detector Development for UV Missile Warning Applications |
| TP-2.2 | 4:35 | 14 | M. Razeghi, P. Kung, F. Shahedipour, razeghi@ece.nwu.edu K. Mi, X. Zhang and V. Kumar | UV photodetectors |

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|---------|------|------------|--|-----------------------------|---|
| TP-2.3 | 4:45 | 21 | T. Li, S. Wang, A. Beck, C. Collins, Bo Yang, R. D. Dupuis, J. C. Campbell, J. Carrano, M. Schurman and Ian Ferguson | jcc@mail.utexas.edu | AlxGa1-xN/GaN Photodiodes |
| TP-2.4 | 4:55 | 66 | P. Kozodoy, E. Tarsa, J. Ibbetson, and B. Keller | kozodoy@nitres.com | Solar-Blind AlGaIn-Based Photodiodes |
| TP-2.5 | 5:05 | 82 | M. Misra, E. Iliopoulos, D. Doppalapudi, H. M. Ng, T. D. Moustakas | tdm@bu.edu (T.D. Moustakas) | Photoconductive detectors fabricated on GaN and AlxGa1-xN films grown by Molecular Beam Epitaxy |
| TP-2.6 | 5:15 | 83 | D. J. H. Lambert, C. J. Eiting, M. M. Wong, U. Chowdhury, T. Li, B. Yang, C. J. Collins, J. C. Campbell, and R. D. Dupuis | dupuis@mail.utexas.edu | Performance of AlxGa1-xN/GaN pin Photodiodes Grown by MQCVD |
| TP-2.7 | 5:25 | 11 | J. C. Roberts, C. A. Parker, J. F. Muth, M. E. Aumer, S. F. LeBoeuf, S. M. Bedair, M. J. Reed | jcrobert@eos.ncsu.edu | UV - visible InGaIn photodetectors |
| TP-2.8 | 5:35 | 3 | J. D. Brown, J. Matthews, J. Boney, P. Srinivasan, J. D. Benson, K. V. Dang, T. Nohava, Wei Yang, S. Krishnakutty, and J. F. Schetzina | jan_schetzina@ncsu.edu | UV digital cameras based on arrays of P-I-N nitride photodiodes |
| TP-2HT | 5:50 | | 5:50-6:20 PM: Open Discussion & Hot Topics | | |
| Posters | | | 6:30-8:00 PM Poster Session (Appetizers and refreshments) | | |
| Session | Time | Abstract # | Authors (Presenter's Name in Bold) | Contact e-mail | Title of Talk |

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|--------|------|-----|---|------------------------|--|
| WA-1 | 8:00 | | <i>III-Nitride Electronic Devices - John Zolper</i> | | |
| WA-1.1 | 8:00 | 104 | Yi Feng Wu | yfwu@nitres.com | Progress and Challenges of GaN Based Microwave HEMT's and Amplifiers |
| WA-1.2 | 8:10 | 10 | L.F.Eastman, J. R. Shealy, W. Schaff, B. K. Ridley, J. Smart, E. Chumbes, V. Tilak, B. Green, H. Kim, and R. Dimitrov | ife@iiv.tn.cornell.edu | Undoped Polarization-Induced (GaN)/AlGaIn/GaN HEMT Technology |

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|--------|------|----|---|------------------------------------|--|
| WA-1.3 | 8:20 | 93 | S. C. Binari, K. Ikossi-Anastasiou, W. Kruppa, J. A. Roussos, R. L. Henry, D. D. Koleske, and A. E. Wickenden | binari@nrl.navy.mil | Traps in GaN HEMTs: Where are they and how do we find them? |
| WA-1.4 | 8:30 | 51 | M. Micovic, N. Nguyen, W. Wong, P. Hashimoto, P. Janke, and C. Nguyen | cnnguyen@hrl.com | GaN-based FETs for low-noise amplifiers |
| WA-1.5 | 8:40 | 61 | X. Hu, M. Asif Khan, J. W. Yang, G. Simin, W. Knap, E. Frayssinet, P. Prystawko, M. Leszczynski, I. Grzegory, S. Porowski, R. Gaska, M. S. Shur | hu@engr.sc.edu | GaN-AlGaIn Heterostructure Field Effect Transistors Over Bulk GaN Substrates |
| WA-1.6 | 8:50 | 38 | I. Daumiller, E. Kohn, C. Kirchner, M. Seyboth, and M. Kamp | daumiller@ebs.e-technik.uni-ulm.de | Demonstration of a GaN/InGaN HFET with high breakdown behaviour |
| WA-1.7 | 9:00 | 62 | M. Asif Khan, X. Hu, G. Simin, J. Yang, R. Gaska, and M. S. Shur | asif@engr.sc.edu | AlGaIn/GaN Buried Channel Metal-Oxide-Semiconductor Heterostructure Field Effect Transistors on SiC Substrates |
| WA-1.8 | 9:10 | 71 | M. S. Shur, R. Gaska, and Asif Khan | shurm@rpi.edu (M. S. Shur) | Modeling of AlGaInN/GaN Based Devices |
| WA-1.9 | 9:20 | 50 | P. Parikh, L. McCarthy, J. Ibbetson, Y. Wu, U. Mishra, and B. Keller | primit@nitres.com | AlGaIn-GaN PNP HBT |
| WA-1HT | 9:40 | | 9:40-10:00 AM: Open Discussion & Hot Topics; 10:00-10:20 AM: Coffee Break | | |

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|--------|-------|----|---|----------------------------|---|
| WA-2 | 10:20 | | <i>Doping, Defects, and Properties of III-Nitrides and Alloys - Dave Look, Fred Schubert</i> | | |
| WA-2.1 | 10:20 | 27 | A. E. Wickenden, D. D. Koleske, R. L. Henry, and M. E. Twigg | wickende@estd.nrl.navy.mil | The contributions of microstructure and impurity compensation to highly resistive GaN |
| WA-2.2 | 10:30 | 80 | E. Glaser, G. Braga, W. Carlos, J. Freitas, R. Henry, D. Koleske, W. Moore, B. Shanabrook, and A. Wickenden | glaser@bloch.nrl.navy.mil | Magnetic Resonance Studies of Mg-Doped GaN Epitaxial Layers Grown by OMCD |
| WA-2.3 | 10:40 | 8 | A. K. Rice and K. J. Malloy | arice@chtm.unm.edu | Microstructural Contributions to Hole Transport in p-type GaN:Mg |
| WA-2.4 | 10:50 | 44 | E. L. Waldron, J. W. Graff, E. F. Schubert, A. Osinsky, W. J. Schaff and | EFSchubert@bu.edu | P-doped AlGaIn/GaN superlattices: Physical properties and device applications |

L. F. Eastman

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|---------|-------|----|---|--|---|
| WA-2.5 | 11:00 | 45 | D. C. Look, Z-Q. Fang, and L. Polenta | david.look@wpafb.af.mil | Hall-Effect and DLTS Fingerprints of Defects in GaN |
| WA-2.6 | 11:10 | 46 | Z-Q. Fang, J. W. Hemsky, and D. C. Look, C. Z. Lu and H. Morkoç | zhaofang.fang@wright.edu | Deep centers and irradiation effects in GaN p-i-n UV detectors |
| WA-2.7 | 11:20 | 65 | S. Goss, A. Young, L. Brillson, D. Look and R. Molnar | goss.21@osu.edu, brillson.1@osu.edu | Variations in Defect Emission and Mobility with Layer Thickness of HVPE GaN |
| WA-2.8 | 11:30 | 86 | I. Usov, B. Stoner and N. Parikh | nparkh@physics.unc.edu | p-type Doping of Epitaxial GaN by Impurity Complexes |
| WA-2.9 | 11:40 | 75 | L. Guido, P. Mitev, M. Gherasimova, B. Gaffey, M. Ahouja and Y. K. Yeo | louis.guido@vt.edu | Isoelectronic Doping of Gallium Nitride with Arsenic |
| WA-2.10 | 11:50 | 22 | M. Mastro, O. Kryliuk, T. Anderson, A. Davydov, A. Shapiro, and V. Demin | davydov@nist.gov | The Thermal Stability of GaN |
| WA-2HT | 12:10 | | 12:10-12:30 AM: Open Discussion & Hot Topics; Workshop Wrap Up 12:30-12:40 PM | | |

Poster Presentation Schedule:

| Session | Abstract # | Authors (Presenter's Name in Bold) | Contact e-mail | Title of Talk |
|---|---|---|-----------------------------------|--|
| TE-1 | Poster Session - Cole Litton, Asif Kahn | | | |
| Substrates and Crystal Growth | | | | |
| TE-1.1 | 103 | Zlatko Sitar | sitar@ncsu.edu | Growth of GaN and AlN single crystals |
| TE-1.2 | 72 | Jeffrey E. Nause | jnause@cermetinc.com | Bulk Aluminum Nitride (AlN) Crystal Growth |
| TE-1.3 | 41 | J. E. Nause, D. Look, and H. Morkoç | jnause@cermetinc.com | Zinc Oxide (ZnO) substrates |
| TE-1.4 | 25 | M. J. Callahan | Michael.Callahan@hanscom.af.mil | Ammonothermal Growth of GaN and AlN Crystals |
| TE-1.5 | 37 | V. Dmitriev, D. Tsvetkov, and Yu. Melnik | vladimir@tdii.com | AlGaIn/GaN multi layer epi wafers fabricated by HVPE |
| TE-1.6 | 26 | D. Koleske, A. Wickenden, R. Henry, and M. Twigg | koleske@estd.nrl.navy.mil | Dependence of GaN grain size and density on growth parameters |
| TE-1.7 | 17 | N. B. Singh, Chris Clarke and J. D. Adam | narsingh_b_singh@md.northgrum.com | Evaluation of Transport Conditions during Vapor Growth of Bulk Crystals |
| Electrical and Optical Characterization | | | | |
| TE-1.8 | 19 | D. C. Look and C. E. Stutz | david.look@wpafb.af.mil | Profiles of Electrical Properties in GaN |
| TE-1.9 | 54 | M. Asif Khan, J. Zhang, J. W. Yang, G. Simin, R. Gaska, and M. S. Shur | asif@engr.sc.edu | Improved light emission from strain-tuned quaternary AlInGaIn/GaN Quantum Wells |
| TE-1.10 | 57 | U. Ozgur, M. Bergmann, H. Casey, Jr., H. Everitt, and J. F. Muth | everitt@aro-emh1.army.mil | Refractive indices determined by waveguide measurements for epitaxial Al _x Ga _(1-x) N films with x=0.0, 0.04, 0.07, 0.10, 0.20 |
| TE-1.11 | 63 | A. Osinsky, L. Chernyak, L. Zhou, I. Adesida, J. W. Graff, and E. F. Schubert | andrei@nizat.com | Characterization of Diodes Based on AlGaIn/GaN Heterostructures and Superlattices for Bipolar Transistor Applications |

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|---------|-----|---|---|
| TE-1.12 | 105 | H. J. Im, Y. Ding and J. P. Pelz pelz.2@osu.edu | Nanometer-scale studies of metal/GaN schottky contacts and GaN/AlGaIn interfaces using Ballistic Electron Emission Microscopy (BEEM) |
| TE-1.13 | 106 | S. Bradley, A. P. Young and L. J. Brillson brillson.1@osu.edu | Influence of AlGaIn Deep Level Defects on AlGaIn/GaN 2DEG Carrier Confinement |
| TE-1.14 | 100 | Devices Rich Molnar rmolnar@ll.mit.edu | HVPE grown GaN avalanche photodiodes |
| TE-1.15 | 77 | D. J. H. Lambert, B. Shelton, T. Dupuis dupuis@mail.utexas.edu Zhu, C. Eiting, M. Wong, U. Chowdhury, R. D. Dupuis, J. J. Huang and M. Feng | Performance of Al _x Ga _{1-x} N/GaN Heterostructure Bipolar Transistors Grown by MOCVD |
| TE-1.16 | 70 | S.L. Rumyantsev , M. S. Shur , R. Gaska , Asif Khan , G. Simin , J. Yang , N. Zhang , S. DenBaars , and U. K. Mishra shurm@rpi.edu (M. S. Shur) | Transient Processes in AlGaIn/GaN Heterostructure Field Effect Transistors |
| TE-1.17 | 101 | E. Alekseev, P. Nguyen-Tan, D. Pavlidis, N. X. Nguyen, C. Nguyen, D.E. Grider pavlidis@umich.edu | Current Injection Characterization of AlGaIn/GaN MODFETs |
| TE-1.18 | 102 | S. Hubbard, E. Alekseev, D. Pavlidis, T. Detchprohm, H. Amano and I. Akasaki pavlidis@umich.edu | Electrical Characteristics of GaN Based PIN Diodes |

6th Annual Wide Bandgap Nitride Workshop
Omni Richmond Hotel in Richmond VA
March 12-15, 2000

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